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(54) A REINFORCED FLEXIBLE TUBULAR PIPE WITH CONVEYING BACK OF LEAK FLUID

VERSTÄRKTES FLEXIBLES ROHR MIT LECKFLÜSSIGKEITSRÜCKFÜHRUNG

TUYAU TUBULAIRE SOUPLE RENFORCE A RENVOI DU LIQUIDE DE FUITE

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- **SCHIMMELPFENNING: "A novel flexible offshore LNG-pipe system with continous operating control, paper OTC 3666" 11TH ANNUAL OTC,30 April 1979 (1979-04-30) - 3 May 1979 (1979-05-03), pages 2711-2717, XP002127799 Houston, Texas, USA**

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Description

[0001] The present invention relates to a reinforced flexible tubular pipe comprising an inner liner that forms a barrier against outflow of the medium that flows through the tubular pipe, said inner liner being encased by at least one reinforcing layer containing a number of profiles that have been coiled around the inner liner in such a manner that the profiles are entirely or partially contained in a lumen that allows transport of fluids in the longitudinal direction of the tubular pipe, and wherein - outside the reinforcing layer - an outer jacket is provided with a view to forming a barrier against unimpeded inflow of fluids and/or gases from the environment surrounding the tubular pipe and to the reinforcing layer. Such a reinforced flexible tubular is disclosed in Schlimmelpfennig, "A novel flexible offshore LNG-pipe system with continuos operating control".

[0002] The reinforcing layer is not secured to the inner liner, but is able to move relative thereto which ensures the flexibility of the tubular pipe. Outside the reinforcing layer, an outer coating is provided with a view to forming a barrier against inflow of fluids and/or gasses from the environment surrounding the tubular pipe to the reinforcing layer.

[0003] However, positioning of reinforcing elements in the outer coating makes it possible to impart to this layer a structural functionality, too. Also, outside the outer jacket, a further reinforcing layer can be provided. To prevent collapse of the inner liner, it is often lined with a flexible steel pipe. In the following this pipe is designated 'carcass'.

[0004] Most often such tubular pipes are used to transport fluids and gases at various depths of sea, and they are used in particular in situations where very high or varying water pressures prevail along the longitudinal axis of the pipe. Examples of such include riser pipes that extend from the seabed and up to an installation on or near sea level. In the technical literature this type of riser pipes is known as risers. Also between installations arranged on the seabed at great depth, or between installations near the surface of the sea, this type of tubular design is employed. Pipes for this use, are known in the technical literature as flowlines or jumpers.

[0005] The coiled reinforcing layer of the tubular pipe is configured of a number of layers of profiles, often of steel, mounted at like or different pitches.

[0006] During manufacture, transport and operation the tubular pipe is exposed to circumferential pressure as well as forces acting along the axis of the tubular pipe. It is thus the task of the reinforcing layer to absorb these forces to prevent the inner liner from being destroyed.

[0007] The specific configuration of the reinforcing layer depends on the use of the tubular pipe. It should be noted in particular in connection with the reinforcing layer that it contains a lumen between the coiled profiles which is necessary to enable the reinforcing profiles to move relative to each other. The movability of the reinforcing profiles is necessary to ensure the flexibility of the tubular pipe.

[0008] It is a problem with the known tubular pipes that a certain diffusion will always occur through the inner liner which means that undesired amounts of gases and condensate will accumulate in the reinforcing layer ia with ensuing corrosion of the reinforcing profiles.

[0009] Furthermore accumulation of pressure in the reinforcing layer due to gas diffusion can cause the outer jacket to burst which will destroy the tubular member.

[0010] Several methods are known for reducing or preventing the destructive effect of diffusion into the reinforcing layer.

[0011] NO 300471 B1 discloses a method of ventilating the reinforcing layer towards the surroundings which is possible when a positive, super-atmospheric pressure prevails between the reinforcing layer and the surroundings.

[0012] A similar method is also described in US patent No 4932810. However, it should be noted that the tubular pipe described in the US disclosure is of a different type.

[0013] WO 98/40657 A1 teaches how it is possible to construct a tubular member of two concentric shells so as to provide therebetween a flushing space. The flushing space thus accomplished is cleaned continually by a medium flowing therethrough.

[0014] Despite the fact that both NO 300471 B1 and WO 98/40657 A1 teach methods suitable for ventilating or cleaning reinforcing layers, both methods are less suitable for the maintenance of a flexible tubular member, the object of which being to transport fluids at great varying depths of sea.

[0015] The unsuitability of the methods is due to the fact that pipes operating at varying depths of sea are often attacked by gases and fluids that penetrate the reinforcing layer with ensuing formation of condensate, said condensate accumulating at the lowermost part of the pipe.

[0016] NO 300471 B1 does not teach a method of removing such condensate, the valves shown in the patent for ventilation acting exclusively on gases that are ventilated at a positive difference of pressure between the reinforcing layer and the environment surrounding the tubular pipe.

[0017] Nor does WO 98/40657 A1 teach a method suitable for removal of condensates from the reinforcing layer on tubular pipes arranged below water at varying depths.

[0018] This is due to the fact that tubular pipes of the kind disclosed therein often contain a mixture of condensate and accumulated gases with an effective density which is substantially lower than that of water.

[0019] A forced flushing of the tubular pipe will therefore not be possible without pressurising the reinforcing layer near the point of entry for the flushing agent to a pressure that exceeds the ambient pressure. Pressurisation of the reinforcing layer may entail a rupture of the

outer jacket of the tubular pipe with ensuing destruction of the tubular pipe, bearing in mind that pressurisation of the tubular pipe with the object of flushing same can only be accomplished in practice provided the pressurisation occurs in the upper part of the tubular pipe.

[0020] In the light of this it is the object of the present invention to provide a reinforced, flexible tubular pipe that completely or partially remedies the above-mentioned drawbacks associated with the prior art pipes.

[0021] In accordance with the present invention this is accomplished by a tubular pipe of the type described in the introductory part which is characterised in that at least one flow path is arranged for conveying fluids from said lumen to the fluid transported in the inner liner of the tubular pipe.

[0022] In this manner it is possible, at all depths of sea, to empty the reinforcing layer without substantial, adverse pressurisation. Further advantageously, the surrounding environment is not exposed to contamination by fluids that derive from the reinforcing layers.

[0023] In some cases, eg in case of transport of aggressive fluids, the conditions of operation can be such that the flow path is advantageously, and as featured in claim 2, configured with means that prevent flow into the lumen of the fluid which is transported in the pipe interior.

[0024] Convenient embodiments of these means can be configured such, as featured in claim 3, that the means consist of a valve that allows flow only in case there is a negative difference in pressure between the pipe interior and the lumen.

[0025] In case the pressure within the pipe only rarely drops below the pressure in the reinforcing layers, the means can conveniently be configured in accordance with claim 4, ie in the form of a pump that forces the flow from the lumen and to the pipe interior, and furthermore the pump can, as featured in claim 5, be configured with a passageway or a bypass valve thereby enabling flow at any time provided there is a negative difference of pressure between the pipe interior and the lumen.

[0026] In this context it should be noted that use of a pump is particularly advantageous, the partial pressure (which is desirably low-value) of eg aggressive fluids in the free volume being hereby controllable, irrespective of the pressure within the inner liner of the pipe.

[0027] In an alternative embodiment there is, as featured in claim 6, provided a safety valve in the flow path. This safety valve can be used to optionally close the flow path completely to flow of fluid or gas, if desired.

[0028] Conveniently, as featured in claim 7, two or more blocking valves are provided that are, flow-wise, arranged on each their side of the means arranged in the flow path. Hereby the advantage is obtained that in case defaults occur in the valve or pump configured in the flow path with ensuing operational shutdowns, such failure can be remedied without resulting exposure of neither the lumen nor the pipe interior to the surroundings.

[0029] Moreover, the reinforced flexible tubular pipe can conveniently, and as featured in claim 8, comprise a coupling element for attachment of the reinforced flexible tubular member on another construction or to another tubular pipe where the flow path extends completely or partially into the coupling element.

[0030] In this manner, it can be completely or partially avoided to perforate the liner and the coating and optionally the reinforcing layer itself.

[0031] Moreover, in practice the reinforced flexible tubular pipe can, as described more detailed in claim 9, comprise at least two reinforced flexible tubular pipes, said tubular pipes being connected in extension of each other by means of connecting elements, and wherein the connecting element is provided with passages that allow fluid and gas in the one reinforced flexible tubular member to flow through the coupling element to the reinforcing layer in the second of the two reinforced flexible tubular pipes.

[0032] A further, preferred embodiment of the reinforced, flexible tubular pipe is, as featured in claim 10, additionally provided with at least one further flow path with a view to introducing to the reinforcing layer fluids or gases for cleaning and maintenance. Such cleaning fluids can be of a nature that prevents attacks on the reinforcement.

[0033] The present invention is particularly advantageous in connection with pipe installations in which the reinforced flexible tubular pipe is, as featured in claim 11, the cleaning and maintaining fluid or gas supplied to the lumen has a density comprised within the range of from 0.9 and 1.1 times the density of the sea water in which the pipe is used.

[0034] Moreover, the reinforced flexible tubular pipe is conveniently constructed in accordance with the features of claim 14 in that it comprises a plurality of reinforced flexible tubular pipes that extend between an installation arranged on the seabed and to a surface vessel or a platform at sea level.

[0035] Finally, claims 12 and 13 feature further convenient embodiments of the invention.

[0036] The invention will now be explained in further detail with reference to the drawings, wherein

Figure 1 is a perspective sketch illustrating the construction of a commonly known tubular pipe;

Figure 2 is an explanatory sketch illustrating the principles of a prior art construction in the form of a section through a tubular pipe according to the invention;

Figure 3 is an explanatory sketch corresponding to Figure 2, depicting, however, a first embodiment of the invention;

Figure 4 is an explanatory sketch corresponding to Figure 3, wherein, however, an alternative embodiment of the invention is shown;

Figure 5 is a sectional view of a connecting means according to the invention;

Figure 6 is a sectional view of an end coupling element according to the invention;

Figure 7 is an explanatory sketch showing an installation comprising a tubular pipe in accordance with the invention.

[0037] Accordingly, Figure 1 shows a sketch of a segment of a flexible tubular pipe of commonly known type, which tubular pipe is often used as riser between installations on the seabed and an installation located at sea level, such as a vessel or a platform. For instance, this could be in connection with the exploitation of oil and/or gases or transport. The tubular pipe can also be used as transport line between two installations that are both located close to sea level, close to the seabed or relatively deep below sea level.

[0038] Such tubular pipes are known today in a wide variety of configurations, and thus Figure 1 serves only to illustrate, the present invention also being useful in connection with reinforced flexible tubular pipes having other configurations.

[0039] As will appear from Figure 1, these tubular pipes consist of an inner liner 3 that encloses a carcass 1 constituted by a metal band 2 which is coiled so as to form an inner pipe, and wherein the metal band 2 is, during coiling, configured with flaps that engage with each other whereby they are caused to lock the individual windings in the coiled band 2 to each other in such a manner that the carcass 1 can be flexed out of its longitudinal direction. The inner carcass 1 thus not being in itself impermeable, the enclosing liner 3 serves to completely or partially prevent fluid or gas from flowing from the pipe interior and out.

[0040] Obviously, the liner 3 can be a more or less integral part of the above-mentioned carcass, albeit shown herein as a separate unit.

[0041] Exteriorly of the liner 3 and conventionally, one or more layers of reinforcing profiles 5,6 are coiled that form windings with very little pitch compared to the longitudinal direction of the tubular pipe. Thus, these windings form a high degree of resistance against the liner 3 bursting due to elevated pressure on the tubular pipe inside which means that the reinforcement formed by these profiles is often designated a pressure reinforcement 4. As will appear from the figure, those profiles 5,6 that constitute the pressure reinforcement 4 may be C-shaped profiles, which profiles have such orientation that two layers of windings coiled around the liner 3 in the same direction engage in each other. However, other profile types, eg Z-shaped and T-shaped profile types, are used for the same purpose.

[0042] At least some of the prior art tubular pipes are, exteriorly of the pressure reinforcement, provided with a further reinforcement consisting of one or more layers of profiles 7,8 that are most often coiled with a substantially larger pitch than the above-mentioned pressure reinforcement profiles 5,6, whereby they are able to effectively absorb the tensile forces in the longitudinal direction of the pipe which may occur during laying or operation of the tubular pipe. Therefore this outer reinforcement is often designated tensile reinforcement.

[0043] In order to ensure that the tubular pipe is flexible and can be bent relative to the longitudinal direction of the tubular pipe, the individual reinforcing profiles 5,6,7,8 are arranged such that there is play between the coils thereof. In combination these plays form a lumen 10 between the reinforcing profiles 5,6,7 and 8 that allows fluid or gas to flow along the longitudinal direction of the tubular pipe.

[0044] Between the above-mentioned reinforcing profiles 5,6,7 and 8, relatively thin layers can be arranged of a material that serves ia to prevent tearing between abutting profiles when the pipes are bent.

[0045] Obviously the above-described composition of profiles serves merely to exemplify a construction of such reinforced flexible tubular pipe and many variations can be made on the basis of this fundamental principle.

[0046] Generally, however, the exterior of the reinforcing layer that comprises said lumen 10 and the reinforcing profiles 5,6,7,8 is provided with an outer jacket 9 that can be configured in a wide variety of ways comprising, however, at least a material layer, preferably of plastics, which serves as a barrier against fluids flowing freely from the surroundings of the tubular pipe and into the free volume 10 between the reinforcing profiles 5,6,7 and 8.

[0047] Operating conditions in which such pipes function are demanding and it is not possible to achieve full guarantee against small amounts of fluids in the form of fluid or gas from the surroundings of the tubular pipe diffusing into the lumen 10 and thus is caused to be in contact with the reinforcing profiles 5,6,7 and 8. In certain cases this means that from the outside of the tubular pipe water diffuses into the lumen 10 and that simultaneously ia water, CO_2 and H_2S diffuse into the lumen from the tubular pipe interior into the lumen 10 which may give rise to an undesired decomposition of the reinforcing profiles 5,6,7 and 8 with an ensuing substantial reduction in the longevity of the tubular pipe. The accumulation of pressure due to the formation of gas in the reinforcing layer will also in certain cases result in the outer jacket of the pipe bursting.

[0048] Figure 2 is an explanatory sketch of the prior art whereas Figures 3 and 4 illustrate two alternative embodiments in accordance with the present invention. Exclusively for the sake of understanding, these figures include a depiction of the inner liner 3, the outer coating 9 and the lumen therebetween and which contains not shown reinforcing profiles.

[0049] Thus, Figure 2 will show that a flow path 11 is provided that extends from its inlet opening that de-

bouches into the lumen 10, and out through the outer coating 9, wherein said flow path 11 is provided with a one-way valve 15 which is so configured that it allows unimpeded flow provided a positive difference in pressure prevails between the reinforcing layer and the surroundings.

[0050] In an operative situation it is hereby possible to have a flow of fluid or accumulated gas from the lumen 10 and out on the outside of the tube when the pressure in the lumen exceeds the ambient pressure.

[0051] In the first embodiment of the invention the flow path, as shown in Figure 3, debouches in the pipe interior 14. As shown in the figure, the flow path includes a pump 12 that is able to actively pump fluid from the lumen to the pipe interior.

[0052] Now, figure 4 shows the second embodiment of the invention wherein, instead of the pump shown in Figure 3, a valve 15 is arranged which is of the one-way type. The shown one-way valve can, in a preferred embodiment, be configured with not shown means for closing the valve completely to flow from both sides in response to given information, thereby further contributing to avoid occurrence of undesired flow of fluids or gases from the pipe interior and into the lumen through the flow path 11. Corresponding means can also be provided in combination with the pump shown in Figure 3 with the result that also in this embodiment, it is ensured to a higher degree that backflow of fluids from the surroundings of the tubular pipe and into the lumen 10 is avoided, and such means can optionally be used both upstream and downstream of the one-way valve or the pump with a view to servicing same in practice without ensuing risk of leak from the lumen and from the pipe interior.

[0053] Obviously, alternative embodiments and other combinations than the two suggested in Figures 3 and 4 are thinkable. In practice tubular pipes with the construction in accordance with the principles shown in Figure 1 are manufactured in final lengths, the pipes in question having considerable diameters and bulks that are handled only with difficulty when very long. Therefor coupling elements are often used for coupling one or more pipes of the type shown in Figure 1, whereby tubular pipes of desired lengths can be produced, the lengths of which exceed the length of a single integral tubular pipe.

[0054] Thus, Figure 5 is a sectional view illustrating a part of a connecting element having a pipe mounted therein which is of the type shown in Figure 1. Thus, this coupling element has a mounting flange 16 with an abutment face 19 and a holding element 17 and 21 for securing a tubular pipe that consists of an inner carcass 1, an inner liner 3, reinforcing profiles 5,6,7 and 8 which are arranged in the lumen 10, and an outer coating 9.

[0055] In a known manner means are provided that are intended to secure the tubular pipe in the coupling element.

[0056] As will appear and in accordance with the invention, a flow passage 18 is provided that extends from the lumen 10 and to the abutment face 19 of the mounting flange which means that this flow passage 18 can be arranged opposite a corresponding flow passage on another connecting element or another construction thereby enabling emptying of the lumen 10 via this flow passage 18.

[0057] Now Figure 6 shows an alternative embodiment of a coupling element according to the invention in the form of an end coupling element, the most significant difference being, in this context, that the flow passage 20 leads to the side of the coupling element which enables direct coupling of a valve thereto in the same manner as is shown in principle in Figures 2, 3 and 4.

[0058] The end coupling element according to Figure 6 is, according to a preferred embodiment of the invention, provided with a duct 20 for the introduction of fluids for maintenance. This means that, at the upper end of the pipe, fluids or gases can be introduced which will subsequently flow in the lumen of the pipe and downwards and consequently effectively treat the reinforcing profiles and optionally other components of the pipe.

[0059] According to a further preferred embodiment of the invention, a flow passage of the type shown in one of the above-described Figures 3 to 4 is provided at the lowermost end of the pipe in such a manner that the maintenance fluids can be discharged thereby.

[0060] Now Figure 7 is an explanatory sketch illustrating an end coupling element 30 for securing a tubular pipe 32 fra eg a vessel 31 or a platform whereby the tubular pipe 32 can be used as riser and is more or less freely suspended from the vessel 31 or the platform and is at the bottom - in a manner known per se - secured to an installation at the seabed by means of an end coupling 33. According to one aspect of the present invention, the end coupling element 30 at the vessel 31 or the platform can be provided with a filling duct as stipulated above for filling maintenance fluids into the lumen in the tubular pipe 32, and the end coupling element 33 at the seabed can be provided with a flow passage as described above in connection with the figures, for discharging fluids from the lumen of the tubular pipe 32.

[0061] Obviously the present invention can be exercised in other manners than the ones shown above, it being possible to exercise the principles of the invention within a very wide framework in connection with pipes, coupling elements and end coupling elements of differing configurations without hereby modifying the fundamental functioning of the invention.

Claims

1. A reinforced flexible tubular pipe comprising an inner liner (3) that forms a barrier against outflow of the medium that flows through the pipe, said inner liner being encased by at least one reinforcing layer (4) containing a number of profiles (5, 6) that have been coiled around the inner liner in such a manner

that the profiles are completely or partially enclosed by a lumen (10) that allows transport of fluids in the longitudinal direction of the pipe, and wherein, outside the reinforcing layer, an outer jacket (9) is provided with a view to forming a barrier against free inflow of fluids and/or gases from the surroundings of the pipe to the reinforcing layer, **characterized in that** at least one flow path (11) is provided for conveying fluids away from said lumen to the fluid that is transported in the inner liner of the pipe.

2. A reinforced flexible pipe according to claim 1, **characterized in that** the flow path is configured with means (12, 15) that prevent flow of the fluid which is transported in the pipe interior into the lumen.

3. A reinforced flexible tubular pipe according to claim 2, **characterized in that** the means are in the form of a valve (15) that allows flow only when a negative difference of pressure prevails between the pipe interior and the lumen.

4. A reinforced flexible tubular pipe according to claim 2, **characterized in that** the means are in the form of a pump (12) that forces the flow from the lumen and into the pipe interior.

5. A reinforced tubular pipe according to claim 4, **characterized in that** the pump is configured with a passageway or a by-pass valve thereby enabling it to always allow flow provided a negative difference in pressure prevails between the pipe interior and the lumen.

6. A reinforced flexible tubular pipe according to any one of the preceding claims, **characterized in that** the flow path further comprises a safety valve.

7. A reinforced flexible tubular pipe according to claims 2 through 6, **characterized in that** two or more blocking valves are provided that are, flowwise, arranged on each their side of the means arranged in the flow path.

8. A reinforced flexible tubular pipe according to any one of the preceding claims, **characterized in that** it comprises a coupling element (16, 17, 21) for securing the reinforced flexible tubular pipe on another construction or to another tubular pipe, and wherein the flow path completely or partially extends into the coupling element.

9. A reinforced flexible tubular pipe according to any one of claims 1 through 8, **characterized in that** the reinforced, flexible tubular pipe comprises at least two reinforced flexible tubular pipes, said tubular pipes being connected in extension of each other by means of a connecting element (16, 17, 21), and wherein the connecting element is provided with ducts (18) that allow fluid and gas within the one reinforced flexible tubular pipe to flow through the connecting element into the reinforcing layer in the second of the two reinforced, flexible tubular pipes.

10. A reinforced flexible tubular pipe according to any one of claims 1 through 9, **characterized in that**, furthermore, at least one further flow path (20) is provided with a view to introducing fluids or gases for cleaning and maintenance to the lumen.

11. A reinforced flexible tubular pipe according to claim 10, **characterized in that** the fluid or gas for cleaning and maintenance supplied to the lumen has a density comprised within the range of from 0.9 to 1.1 times the density of the seawater in which the pipe is used.

12. A reinforced flexible tubular pipe according to any one of claims 1 through 9, **characterized in that** the reinforced flexible tubular pipe extends between an upper and a lower end which is situated at a level below the upper end, and **in that** the flow path for conveying fluids and gases away from the reinforcing layer is arranged at the lower end of the reinforced flexible tubular pipe.

13. A reinforced tubular pipe according to claim 10, **characterized in that** the flow path for supplying fluids or gases for cleaning or maintenance is configured at the upper end of the reinforced flexible tubular pipe.

14. A reinforced tubular pipe for use in a pipe installation that extends between an installation arranged at the seabed and to a surface vessel or platform at sea level, **characterized in that** it comprises several reinforced, flexible tubular pipes as defined in any of the previous claims.

Patentansprüche

1. Verstärktes flexibles röhrenförmiges Rohr, umfassend eine Innenauskleidung (3), die eine Barriere gegen Herausfließen des Mediums, das durch das Rohr fließt, bildet, wobei die Innenauskleidung von mindestens einer Armierungslage (4) umgeben ist, die eine Anzahl von Profilen (5, 6) enthält, die um die Innenauskleidung auf eine solche Weise herumgewunden worden sind, dass die Profile vollständig oder teilweise von einem Hohlraum (10) umschlossen sind, der einen Transport von Fluiden in der Längsrichtung des Rohrs zulässt, und wobei außerhalb der Armierungslage ein äußerer Mantel (9) vorgesehen ist, mit der Absicht, um eine Barriere

gegen ungehemmtes Hineineinfließen von Fluiden und/oder Gasen von der Umgebung des Rohrs zur Armierungslage zu bilden, **dadurch gekennzeichnet, dass** mindestens ein Durchflussweg (11) zum Fördern von Fluiden weg von dem Hohlraum zu dem Fluid, das in der Innenauskleidung des Rohrs transportiert wird, vorgesehen ist.

2. Verstärktes flexibles Rohr nach Anspruch 1, **dadurch gekennzeichnet, dass** der Durchflussweg mit Einrichtungen (12, 15) ausgeführt ist, die einen Fluss des Fluids, das im Rohrinneren transportiert wird, in den Hohlraum verhindern.

3. Verstärktes flexibles röhrenförmiges Rohr nach Anspruch 2, **dadurch gekennzeichnet, dass** die Einrichtungen in der Form eines Ventils (15) vorliegen, das einen Fluss nur zulässt, wenn eine negative Druckdifferenz zwischen dem Rohrinneren und dem Hohlraum vorherrscht.

4. Verstärktes flexibles röhrenförmiges Rohr nach Anspruch 2, **dadurch gekennzeichnet, dass** die Einrichtungen in der Form einer Pumpe (12) vorliegen, die den Fluss von dem Hohlraum und in das Rohrinnere drückt.

5. Verstärktes röhrenförmiges. Rohr nach Anspruch 4, **dadurch gekennzeichnet, dass** die Pumpe mit einem Durchgangs- oder einem Umgehungsventil ausgeführt ist, wodurch es ermöglicht wird, dass immer ein Fluss zugelassen wird, vorausgesetzt, dass eine negative Druckdifferenz zwischen dem Rohrinneren und dem Hohlraum vorherrscht.

6. Verstärktes flexibles röhrenförmiges Rohr nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der Durchflussweg weiter ein Sicherheitsventil umfasst.

7. Verstärktes flexibles röhrenförmiges Rohr nach den Ansprüchen 2 bis 6, **dadurch gekennzeichnet, dass** zwei oder mehr Absperrventile bereitgestellt sind, die in Flussrichtung auf jeder ihrer Seite von den Einrichtungen angeordnet sind, die im Durchflussweg angeordnet sind.

8. Verstärktes flexibles röhrenförmiges Rohr nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** es ein Kopplungselement (16, 17, 21) zum Sichern des verstärkten flexiblen röhrenförmigen Rohrs auf einer anderen Konstruktion oder an einem anderen röhrenförmigen Rohr umfasst, und wobei sich der Durchflussweg vollständig oder teilweise im Kopplungselement erstreckt.

9. Verstärktes flexibles röhrenförmiges Rohr nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** das verstärkte flexible röhrenförmige Rohr mindestens zwei verstärkte flexible röhrenförmige Rohre umfasst, wobei die röhrenförmigen Rohre mittels eines Verbindungselements (16, 17, 21) in gegenseitiger Verlängerung verbunden sind, und wobei das Verbindungselement mit Kanälen (18) versehen ist, die zulassen, dass Fluid und Gas in dem einen verstärkten flexiblen röhrenförmigen Rohr durch das Verbindungselement hindurch in die Armierungslage in dem zweiten der zwei verstärkten flexiblen röhrenförmigen Rohre hineinfließt.

10. Verstärktes flexibles röhrenförmiges Rohr nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** weiter mindestens ein weiterer Durchflussweg (20) vorgesehen ist, mit der Absicht, Fluide oder Gase zur Reinigung und Instandhaltung zum Hohlraum einzuführen.

11. Verstärktes flexibles röhrenförmiges Rohr nach Anspruch 10, **dadurch gekennzeichnet, dass** das Fluid oder Gas zur Reinigung und Instandhaltung, das dem Hohlraum zugeführt wird, eine Dichte aufweist, die im Bereich von 0,9 bis 1,1 mal die Dichte des Meerwassers eingeschlossen ist, in dem das Rohr verwendet wird.

12. Verstärktes flexibles röhrenförmiges Rohr nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** sich das verstärkte flexible röhrenförmige Rohr zwischen einem oberen und einem unteren Ende erstreckt, das sich in einer Höhe unter dem oberen Ende befindet, und dadurch, dass der Durchflussweg zum Fördern von Fluiden und Gasen weg von der Armierungslage am unteren Ende des verstärkten flexiblen röhrenförmigen Rohrs angeordnet ist.

13. Verstärktes röhrenförmiges Rohr nach Anspruch 10, **dadurch gekennzeichnet, dass** der Durchflussweg zur Zuführung von Fluiden oder Gasen zur Reinigung oder Instandhaltung am oberen Ende des verstärkten flexiblen röhrenförmigen Rohrs ausgeführt ist.

14. Verstärktes röhrenförmiges Rohr zur Verwendung in einer Rohrinstallation, die sich zwischen einer am Meeresgrund angeordneten Installation und zu einem Überwasserfahrzeug oder einer Plattform auf Meereshöhe erstreckt, **dadurch gekennzeichnet, dass** es mehrere verstärkte flexible röhrenförmige Rohre, wie in einem der vorangehenden Ansprüche definiert, umfasst.

Revendications

1. Un tuyau tubulaire souple renforcé, comprenant un revêtement intérieur (3), formant une barrière contre une fuite du milieu qui s'écoule à travers le tuyau, ledit revêtement intérieur étant entouré par au moins une couche de renforcement (4) contenant une pluralité de profilés (5, 6) ayant été bobinés autour du revêtement intérieur, de manière que les profilés soient complètement ou partiellement enclos par un lumen (10) permettant le transport de fluides dans la direction longitudinale du tuyau, et dans lequel, à l'extérieur de la couche de renforcement, est prévue une chemise extérieure (9), dans le but de former une barrière contre un écoulement de fluides et/ou de gaz entrant librement, provenant de l'environnement du tuyau sur la couche de renforcement, **caractérisé en ce qu'**au moins un chemin d'écoulement (11) est prévu pour transporter des fluides, pour les évacuer dudit lumen et les amener au fluide transporté dans le revêtement intérieur du tuyau.

2. Un tuyau souple renforcé selon la revendication 1, **caractérisé en ce que** le chemin d'écoulement est configuré avec des moyens (12, 15) empêchant l'écoulement de fluide transporté dans le tuyau à l'intérieur du lumen.

3. Un tuyau tubulaire souple selon la revendication 2, **caractérisé en ce que** les moyens se présentent sous la forme d'une soupape (15) permettant un écoulement uniquement lorsqu'une différence de pression négative prévaut entre l'intérieur du tuyau et le lumen.

4. Un tuyau tubulaire souple selon la revendication 2, **caractérisé en ce que** les moyens se présentent sous la forme d'une pompe (12) forçant l'écoulement à sortir du lumen et à pénétrer à l'intérieur du tuyau.

5. Un tuyau tubulaire souple selon la revendication 4, **caractérisé en ce que** la pompe est configurée avec une voie de passage, ou bien un clapet de dérivation, de manière à lui permettre qu'il puisse toujours y avoir un écoulement de fluide dans le cas où une différence de pression négative prévaut entre l'intérieur du tuyau et le lumen.

6. Un tuyau tubulaire souple selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le chemin d'écoulement comprend en outre une soupape de sûreté.

7. Un tuyau tubulaire souple selon les revendications 2 à 6, **caractérisé en ce que** deux soupapes de blocage ou plus sont prévues qui, fluidiquement, sont agencées chacune sur un côté des moyens agencés dans le chemin d'écoulement.

8. Un tuyau tubulaire souple selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**il comprend un élément de raccordement (16, 17, 21) pour fixer le tuyau tubulaire souple renforcé sur une autre construction ou sur un autre tuyau tubulaire, et dans lequel le chemin d'écoulement s'étend complètement ou partiellement à l'intérieur de l'élément de raccordement.

9. Un tuyau tubulaire souple selon l'une quelconque des revendications 1 à 8, **caractérisé en ce que** le tuyau tubulaire souple renforcé comprend au moins deux tuyaux tubulaires souples renforcés, lesdits tuyaux tubulaires étant connectés en extension de chaque autre au moyen d'un élément de raccordement (16, 17, 21), et dans lequel l'élément de raccordement est muni de conduits (18) permettant au fluide et au gaz se trouvant à l'intérieur d'un tuyau tubulaire souple renforcé de s'écouler à travers l'élément de raccordement, en s'écoulant dans la couche de renforcement située dans le deuxième des deux tuyaux tubulaires souples renforcés.

10. Un tuyau tubulaire souple selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que**, en outre, au moins un autre chemin d'écoulement (20) est prévu dans le but d'introduire des fluides ou des gaz, dans un but de nettoyage et d'entretien du lumen.

11. Un tuyau tubulaire souple selon la revendication 10, **caractérisé en ce que** le fluide ou le gaz, devant assurer le nettoyage et l'entretien, fournis au lumen, a une densité dans la plage de 0,9 à 1,1 fois la densité de l'eau de mer dans laquelle le tuyau est utilisé.

12. Un tuyau tubulaire souple selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** le tuyau tubulaire souple renforcé s'étend entre une extrémité supérieure et une extrémité inférieure, située à un niveau au-dessous de l'extrémité supérieure, et **en ce que** le chemin d'écoulement devant transporter les fluides et les gaz, pour les évacuer de la couche de renforcement, est agencé à l'extrémité inférieure du tuyau tubulaire souple renforcé.

13. Un tuyau tubulaire souple selon la revendication 10, **caractérisé en ce que** le chemin d'écoulement pour la fourniture de fluides ou de gaz pour le nettoyage et l'entretien est configuré à l'extrémité supérieure du tuyau tubulaire souple renforcé.

14. Un tuyau tubulaire renforcé pour utilisation dans une installation de tuyauterie s'étendant entre une installation agencée au fond de la mer et un vais-

seau ou une plate-forme de surface, située au niveau de la mer, **caractérisé en ce qu'**il comprend une pluralité de tuyaux tubulaires souples renforcés, tel que définis selon l'une quelconque des revendications précédentes.

Fig. 1

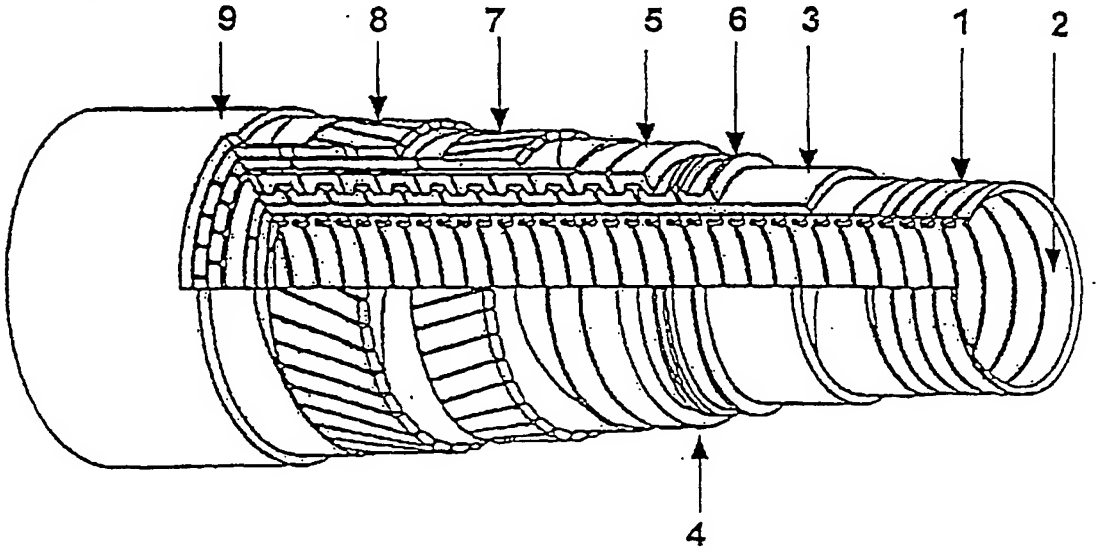


Fig. 2

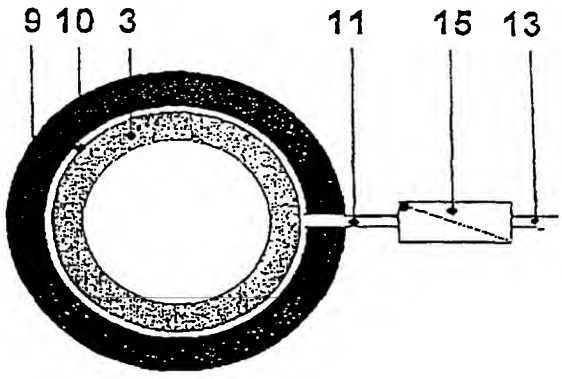


Fig. 3

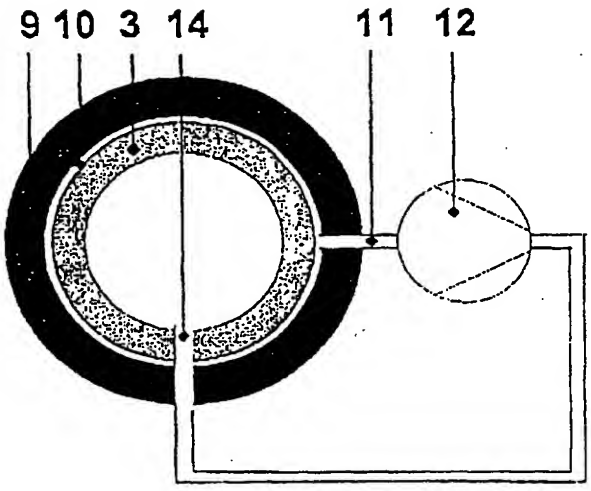


Fig. 4

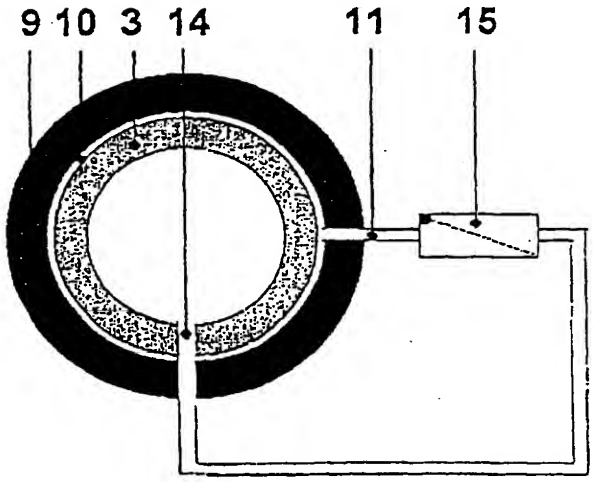


Fig. 5

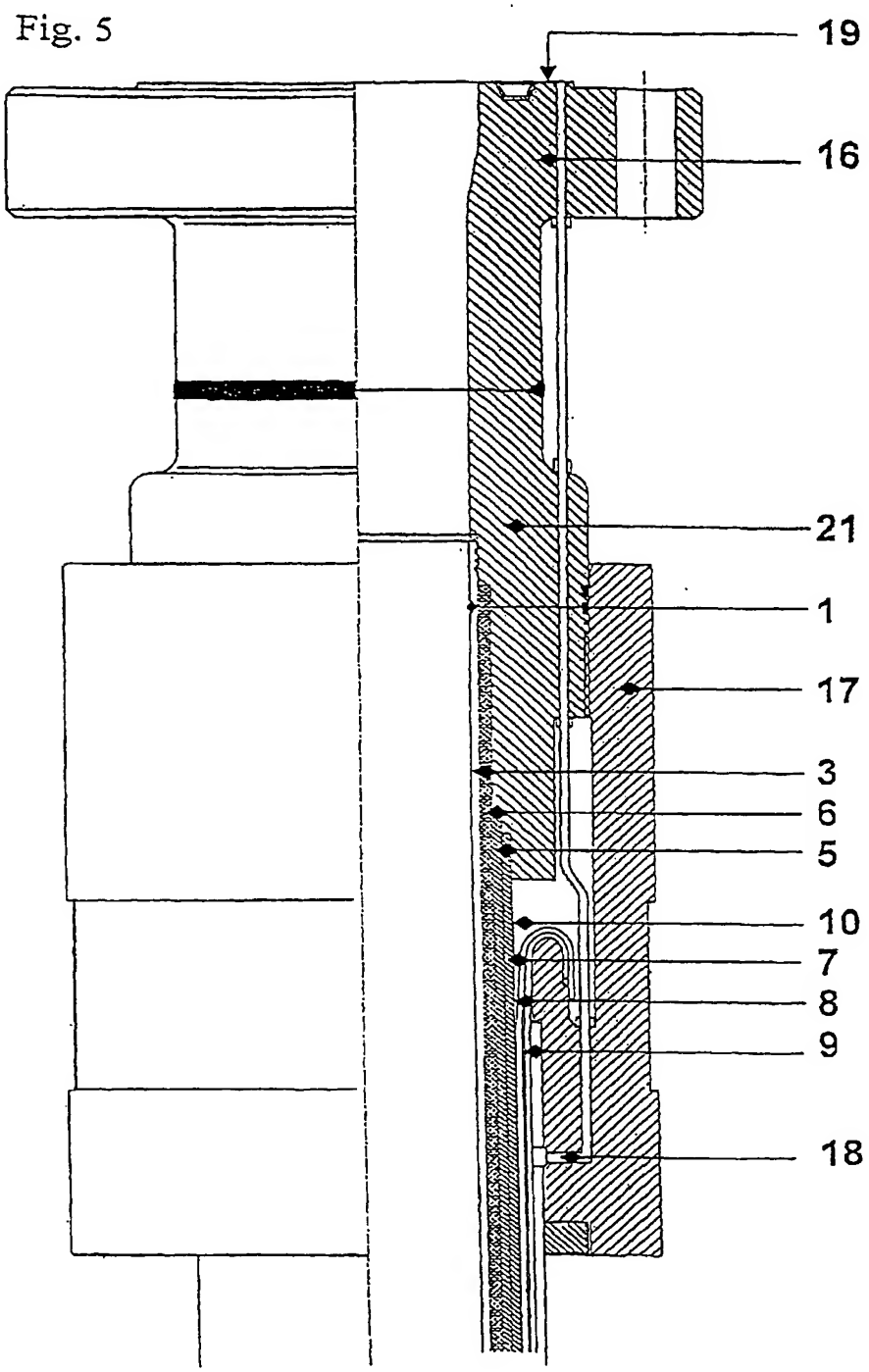


Fig. 6

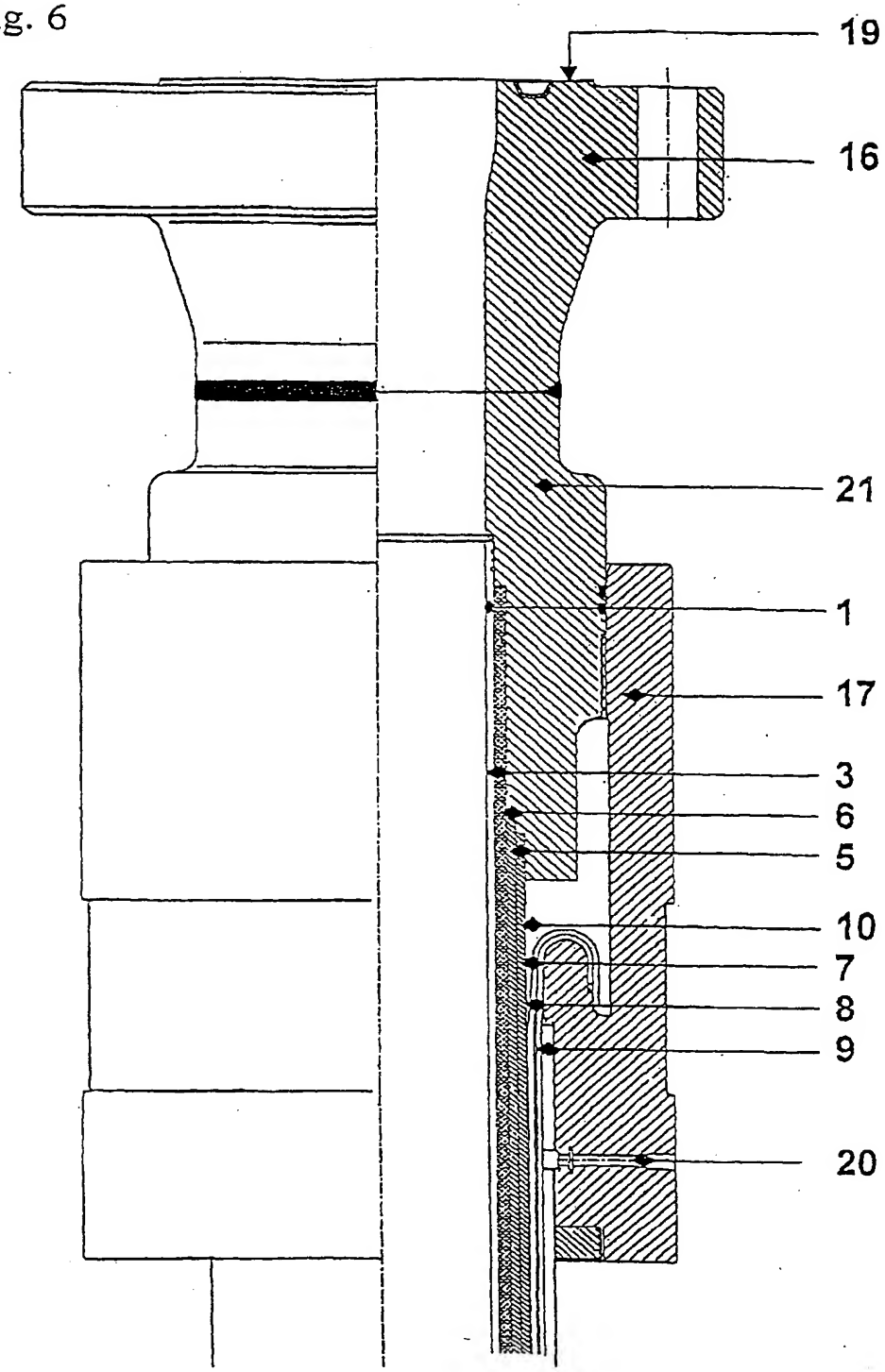
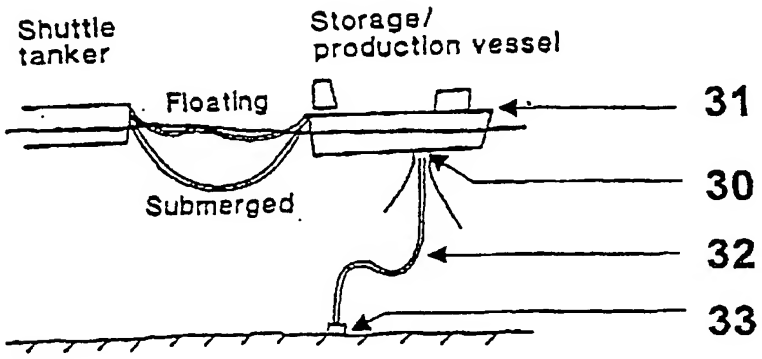


Fig. 7


Shuttle tanker
Storage/ production vessel
Floating
Submerged
31
30
32
33